REMARKS

This amendment responds to the office action mailed October 1, 2002. In the office action the Examiner:

Rejected claims 1, 6, 9, 12-14, 16, 17, 20, 23, 32, 35, 38-40, 42, 43, 46, 60-62 and 66 under 35 U.S.C. 102(b) as being anticipated by Liaw et al. (U.S. Patent No. 5,891,769);

Rejected claims 2-5, 28-31 and 63 under 35 U.S.C. 103(a) as being unpatentable over Liaw et al. in view of Pogossian et al., J. Opt. Soc. Am. A. 16, p. 591;

Rejected claims 7, 8, 10, 11, 18, 19, 21, 24-27, 33, 34, 36, 37, 44, 45 and 47 under 35 U.S.C. 103(a) as being unpatentable over Liaw et al. in view of Pogossian et al.;

Rejected claims 15, 22, 41, 48-50, 57-59, 64, 65 and 67 as being unpatentable over Liaw et al. in view of Pogossian et al; and

Rejected claims 51-56 under 35 U.S.C. 103(a) as being unpatentable over Liaw et al. in view of Pogossian et al.

CLAIM AMENDMENTS AND SPECIFICATION AMENDMENTS

With this amendment claims 62-67 have been cancelled. Claims 1 and 51 have been amended to recite that a second graded layer is formed immediately over a first graded layer. This amendment to claims 1 and 51 is supported by paragraph 42 of the specification. Claims 23 and 61 have been amended to add a step of etching a pattern in a substrate and to form a first graded layer within the pattern. This amendment is supported by figures 4 and 5 and text describing these figures in the specification. Claims 16, 20, 29, 31, 42, 46, 53, 57, and 60 have been amended to improve clarity and/or to correct for antecedent basis. No new matter has been added.

Paragraphs 51 through 53 of the specification were amended to include the proper notation for degrees Celsius. No new matter has been added.

THE REJECTION UNDER 35 U.S.C. SECTION 102

The Patent and Trademark Office (hereinafter the "PTO") has rejected claims 1, 6, 9, 12-14, 16, 17, 20, 23, 32, 35, 38-40, 42, 43, 46, 60-62 and 66 under 35 U.S.C. 102(b) as being anticipated by Liaw et al. (U.S. Patent No. 5,891,769).

Claims 1, 6, 9, 12-14, 16, 17, 20 and 60. Applicants respectfully submit that claims 1, 6, 9, 12-14, 16, 17, 20, and 60 are not anticipated by Liaw *et al.* The PTO states that Liaw et al. teaches the deposition of a silicon-germanium layer in which the germanium concentration increases in the height of the layer, a layer of constant composition SiGe deposited on the first layer, and a third layer of graded SiGe in which the germanium concentration is decreased. The only referene to such a structure is found at column 1, lines 27-39. However, the structure at Liaw 1:27-39 is not claimed in claims 1 or 60 of the instant application. Claims 1 and 60 recite the formation of a second graded layer on a first graded layer. For clarity, Applicants have amended claims 1 and 60 to recite that the second graded layer is formed immediately over the first graded layer. Thus, claims 1 and 60 do not encompass a structure that includes an intermediate layer having a constant composition SiGe as disclosed in column 1, lines 27-39, of Liaw et al. Furthermore, no section of Liaw et al discloses the structures formed by the methods recited in claims 1 and 60 of the instant application. For this reason, claims 1 and 60 are not anticipated by Liaw et al. Claims 6, 9, 12-14, 16, 17 and 20 ultimately depend from claim 1 and are therefore patentable over Liaw et al. for at least the same reason that claim 1 is patentable over Liaw et al. Applicants therefore request that the 35 U.S.C. 102(b) rejection of claims 1, 6, 9, 12-14, 16, 17, 20 and 60 be withdrawn.

Claims 23, 32, 35, 38-40, 42, 43, 46, and 61. Claims 23 and 61 have been amended to recite etching a pattern into a substrate and forming a first graded layer within the pattern. This embodiment of the invention is illustrated, for example, in Figures 4 and 5 of the specification. Liaw et al. does not disclose etching a pattern into a substrate and forming a first graded layer within the pattern. Thus, the rejection under 35 U.S.C. 102(b) has been obviated with respect to claims 23 and 61. Claims 32, 35, 38-40, 42, 43, and 46 ultimately depend from claim 23 and are therefore patentable over Liaw et al. for the same reason that claim 23, as amended, is patentable over the reference. Applicants therefore respectfully request that the 35 U.S.C. 102(b) rejection of claims 23, 32, 35, 38-40, 42, 43, 46, and 61 be withdrawn.

Claims 62 and 66. Claims 62 and 66 have been cancelled, rendering the rejection of these claims moot.

THE FIRST REJECTION UNDER 35 U.S.C. SECTION 103 OVER LIAW ET AL. IN VIEW OF POGOSSIAN ET AL.

The PTO has rejected claims 2-5, 28-31 and 63 under 35 U.S.C. 103(a) as being unpatentable over Liaw et al. in view of Pogossian et al., J. Opt. Soc. Am. A. 16, p. 591.

Claims 2-5 and 28-31. The PTO relies on Liaw et al. for the same reasons stated in the discussion of the 35 U.S.C. 102(b) rejection. The PTO states that Liaw et al. differs from claims 2-5, 28-31 and 63 in the addition of a cladding layer. Pogessian et al. provides a survey of known SiGe waveguides and then proposes a method by which a higher concentration of Ge can be incorporated into a SiGe layer of a waveguide. Next, the PTO states that it would have been obvious to one of ordinary skill in the art to modify the Liaw et al. process in view of the Pogessian et al. reference in order to improve the optical properties of the SiGe layers. With respect to claims 2-5 and 28-31, Applicants traverse the rejection on three grounds.

First, the PTO has failed to satisfy its burden of establishing a *prima facie* case of obviousness because the combination of Liaw et al. and Pogessian et al. fails to teach each and every element of independent claims 1 and 23. Claims 2-5 and 28-31 ultimately depend from either claim 1 or 23. In particular, as discussed in the 35 U.S.C. 102 rejection above, Liaw et al. does not teach or suggest the formation of a second graded layer immediately over a first graded layer. Pogessian et al. fails to remedy this deficiency.

Second, Applicants submit that it would not have been obvious to one of ordinary skill in the art to modify the Liaw et al. process in view of the Pogessian et al. reference in order to increase the optical properties of the SiGe layers because they are nonanalogous art. The Liaw et al. process is directed to the formation of a strained layer over a relaxed layer in order to make electrical devices such as strain-enhanced mobility field effect transistors. Waveguides are not referenced, even in passing, in Liaw et al. In the absence of any mention

of waveguides in Liaw et al., there is no suggestion that Liaw et al. can be combined with the waveguides of Pogessian et al.

Third, the only discussion in Liaw *et al.* of a structure even remotely related to the structures produced by the claimed methods is at page 1, lines 27-39 in the background section of the reference. In this single discussion, the structure is referred to as disadvantageous. (Liaw et al. 1:35-39). Thus, it is highly unlikely that one of skill in the art would modify the structure that is described as "disadvantageous" in Liaw et al. in view of anything discussed in Pogessian et al.

For these reasons, Applicants respectfully request that the 35 U.S.C. 103 rejection of claims 2-5 and 28-31 be withdrawn.

Claim 63. Claim 63 has been cancelled, rendering the rejection of this claim moot.

THE SECOND AND THIRD REJECTIONS UNDER 35 U.S.C. SECTION 103 OVER LIAW ET AL. IN VIEW OF POGOSSIAN ET AL.

The PTO has rejected claims 7, 8, 10, 11, 15, 18, 19, 21, 22, 24-27, 33, 34, 36, 37, 41, 44, 45, 47-50, 57-59, 64, 65 and 67 under 35 U.S.C. 103(a) as being unpatentable over Liaw et al. in view of Pogossian et al. The PTO states that the cited references differ from claims 7, 8, 10, 11, 18, 19, 21, 24-27, 33, 34, 36, 37, 44, 45 in the germanium content. Next, the PTO states that in the absence of unexpected results, it would have been obvious to determine through routine experimentation the optimum, operable germanium contents in the graded layers in order to obtain the desired properties. The PTO provides similar arguments for claims 15, 22, 41, 48-50, 57-59, 64, 65, and 67. Applicants respectfully traverse the rejection for the reasons set forth below.

As discussed in the sections above, the only reference in Liaw *et al.* to a structure even remotely related to the structures produced by the claimed methods is in the background section. Yet, in this single reference, the structure is referred to as disadvantageous. (Liaw et al. 1:35-39). Thus, it is highly unlikely that one of skill in the art would modify the structure that is described as "disadvantageous" in Liaw et al. in view of anything discussed in Pogessian et al. or, for that matter, in the known art.

Claims 7, 8, 10, 11, 15, 18, 19, 21 and 22. The rejection of claims 7, 8, 10, 11, 15, 18, 19, 21 and 22 is traversed for the additional reason that the PTO has failed to satisfy its burden of establishing a *prima facie* case of obviousness. The combination of Liaw et al. and Pogessian et al. fails to teach each and every element of claim 1. Claims 7, 8, 10, 11, 15, 18, 19, 21 and 22 ultimately depend from claim 1. In particular, as discussed in the 35 U.S.C. 102 rejection above, Liaw et al. does not teach or suggest the formation of a second graded layer immediately over a first graded layer. Pogessian et al. fails to remedy this deficiency.

Claims 24-27, 33, 34, 36, 37, 41, 44, 45, and 47-50. The rejection of claims 24-27, 33, 34, 36, 37, 41, 44, 45, and 47-50 is traversed for the additional reason that claim 23 has been amended to recite etching a pattern into a substrate and forming a first graded layer within the pattern. Liaw et al. does not disclose etching a pattern into a substrate and forming a first graded layer within the pattern. Claims 24-27, 33, 34, 36, 37, 41, 44, 45, and 47-50 ultimately depend from claim 23 and are therefore patentable over Liaw et al. for the same reason that claim 23, as amended, is patentable over the reference.

Claims 57-59. Applicants traverse the rejection of claim 57-59 on the basis that neither of the cited references discloses etching a pattern in a substrate and forming a first graded layer on the pattern etched in the substrate as recited in claim 57. Therefore, the PTO has not satisfied its burden of establishing a *prima facie* case of obviousness. Claims 58 and 59 depend from claim 57 and are therefore patentable over the cited art for the same reason that claim 57 is patentable over the cited art.

Claims 64, 65 and 67. Claims 64, 65 and 67 have been cancelled, rendering the rejection of these claims moot.

For the reasons discussed above, Applicants respectfully request that the 35 U.S.C. 103 rejection of claims 7, 8, 10, 11, 15, 18, 19, 21, 22, 24-27, 33, 34, 36, 37, 41, 44, 45, 47-50, and 57-59 be withdrawn.

THE FIFTH REJECTION UNDER 35 U.S.C. SECTION 103 OVER LIAW ET AL. IN VIEW OF POGOSSIAN ET AL.

The PTO has rejected claims 51-56 under 35 U.S.C. 103(a) as being unpatentable over Liaw et al. in view of Pogossian et al. Applicants traverse the rejection on the basis that the PTO has failed to satisfy its burden of establishing a *prima facie* case of obviousness.

The combination of Liaw et al. and Pogessian et al. fails to teach each and every element of claims 51. Claims 52- 56 ultimately depend from claim 51. Claim 51 has been amended to recite a second graded layer formed immediately over a first graded layer. Liaw et al. does not teach or suggest the formation of a second graded layer immediately over a first graded layer. As noted above, Pogessian et al. fails to remedy this deficiency. For this reasons, Applicants respectfully request that the rejection of claims 51-56 by withdrawn.

CONCLUSION

In view of the foregoing, Applicants believe that all of the claims are now in condition for allowance and respectfully request the Examiner to pass the subject application to issue. If for any reason the Examiner believes any of the claims are not in condition for allowance, he is encouraged to phone the undersigned at (650) 849-7777 so that any remaining issues may be resolved.

Aside from the fee for the petition for extension of time, no additional fee is believed due for filing this response. However, if a fee is due, please charge such fee to Pennie & Edmonds LLP's Deposit Account No. 16-1150.

Respectfully submitted,

Date: March 3, 2003

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APPENDIX A

MARKED VERSION OF PARAGRAPHS IN THE SPECIFICATION

U.S. PATENT APPLICATION SERIAL NO. 09/866,172 (ATTORNEY DOCKET NO. 005926/AKT/BG)

Please replace paragraph 51 with the following:

[0051] First, a predetermined pattern 611 is formed on a substrate 210 using standard photolithographic techniques known in the art (Step 510). The substrate 210 is any substrate suitable for opto-electronic device fabrication, preferably Si. Next, the pattern is etched in the substrate 210 using etching techniques known in the art. (Step 515, Figure 5(a)) The substrate surface is then cleaned to remove contaminants, such as native oxides that are formed when the surface of the substrate is exposed to air, prior to placing the etched substrate 210 in the deposition chamber 12. (Step 520). In one such cleaning technique, the substrate is pre-processed by dipping it in a water-based hydroflouric acid solution. The wafer is then placed in the deposition chamber and baked at about 900°C for approximately one minute.

Please replace paragraph 52 with the following:

[0052] Where lower temperatures are desired, a dedicated pre-clean chamber such as the one used in the Epi Centura system available from Applied Materials of Santa Clara, CA, may be used to perform the cleaning step. In this case, the wafer is first dipped in a water-based solution of hydroflouric acid. Next, the wafer is placed in the pre-clean chamber and baked at a first temperature for a predetermined time interval and then baked at a second temperature for a second predetermined time interval. In one instance, the first bake is performed at about [750 – 770 C] 750°C – 770°C and the second bake is performed at temperatures in the range of about [770 – 795 C] 770°C –795°C.

Please replace paragraph 53 with the following:

[0053] The cleaned substrate 210 is then loaded on susceptor 20 between domes 14 and 16 (Step 530). Next, chamber 12 is heated to the desired temperature using the high intensity lamps 34. (Step 540). Preferably, chamber 12 is heated to a temperature between about [550 C and 1200 C] <u>550°C and 1200°C</u>. More preferably, chamber 12 is heated to about [850 - 1000] <u>850°C -1000°C</u>. The first and second source gases 130 and 132 and dilutant gas134 are next introduced into chamber 12. (Step 550). The pressure in chamber 12 is then adjusted until the desired pressure is reached. (Step 560). For low pressure CVD, the pressure in chamber 12 is maintained below 760 Torr. Although Steps 540, 550 and 560 have been described as having been performed in a particular sequence, those skilled in the art will recognize that these steps may be performed in any order.

APPENDIX B

MARKED VERSION OF THE CLAIMS UPON ENTRY OF THE AMENDMENT UNDER 37 C.F.R. § 1.111 IN RESPONSE TO THE OFFICE ACTION MAILED 10/01/02

U.S. PATENT APPLICATION SERIAL NO. 09/866,172 (ATTORNEY DOCKET NO. 005926/AKT/BG)

1. (Amended) A method of forming a planar waveguide structure, comprising:

forming a first graded layer on a substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the first graded layer; and

forming a second graded layer [on] immediately over the first graded layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

16. (Amended) The method of claim 13 wherein the chemical vapor deposition process comprises:

introducing into a deposition chamber a first source gas for forming silicon film on a substrate;

introducing into a deposition chamber a second source gas for forming SiGe film on a substrate; and

introducing H_2 into the deposition chamber while maintaining a determined pressure and temperature in the deposition chamber.

20. (Amended) The method of claim 16 wherein the chemical vapor deposition process for forming the first and second graded layers comprises:

controlling the flow rate of the second source gas according to a determined concentration profile of Ge on a substrate; and

forming a film on a substrate, the film comprising Ge at a first concentration at a first point in the film and a second concentration different from the first concentration at a second point in the film.

23. (Amended) A method of forming a planar waveguide structure, comprising:

etching a pattern into a substrate;

forming a first graded layer [on a substrate] within said pattern, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the layer;

forming a uniform layer on the first graded layer, the uniform layer containing silicon and germanium wherein the germanium concentration is constant; and

forming a second graded layer on the uniform layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

29. (Amended) The method of claim [29] 28 wherein the blocking layer [is] comprises epitaxial silicon.

31. (Amended) The method of claim 30 wherein the cladding layer [is] comprises epitaxial silicon.

42. (Amended) The method of claim 29 wherein the chemical vapor deposition process comprises:

introducing into a deposition chamber a first source gas for forming silicon film on a substrate;

introducing into a deposition chamber a second source gas for forming SiGe film on a substrate; and

introducing H_2 into the deposition chamber while maintaining a [determined] predetermined pressure and temperature in the deposition chamber.

46. (Amended) The method of claim 42 wherein the chemical vapor deposition process for forming the first and second graded layers comprises:

controlling the flow rate of the second source gas according to a determined concentration profile of Ge on a substrate; and

forming a film on a substrate, the film comprising Ge at a first concentration at a first point in the film and a second concentration different from the first concentration at a second point in the film.

51. (Amended) A computer readable medium comprising executable program instructions that when executed cause a digital processing system to perform a method comprising:

forming a first graded layer on a substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the first graded layer; <u>and</u>

forming a second graded layer [on] <u>immediately over</u> the first graded layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

53. (Amended) The method of claim 51 wherein the chemical vapor deposition process comprises executable program instructions for:

introducing into a deposition chamber a first source gas for forming silicon film on a substrate;

introducing into a deposition chamber a second source gas for forming SiGe film on a substrate; <u>and</u>

introducing H_2 into the deposition chamber while maintaining a determined pressure and temperature in the deposition chamber.

57. (Amended) A method of forming a planar waveguide structure, comprising:

etching a pattern in a substrate;

forming a first graded layer on the pattern etched in the substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the layer;

forming a uniform layer on the first graded layer, the uniform layer containing silicon and germanium wherein the germanium concentration is constant; <u>and</u>

forming a second graded layer on the uniform layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

60. (Amended) A method of forming a planar waveguide structure, comprising:

forming a first graded layer on a substrate, wherein the first graded layer comprises a first and a second optical material, wherein the concentration of the first optical material and

the index of refraction of the first graded layer increases with the height of the first graded layer; and

forming a second graded layer [on] immediately over the first graded layer, the second graded layer comprising the first and second optical materials wherein the concentration of the first optical material and the index of refraction of the second layer decreases with the height of the second graded layer.

61. (Amended) A method of forming a planar waveguide structure, comprising:

etching a pattern into a substrate;

forming a first graded layer [on a substrate] within said pattern, wherein the first graded layer comprises a first and a second optical material, wherein the concentration of the first optical material and the index of refraction of the first graded layer increases with the height of the first graded layer;

forming a uniform layer on the first graded layer, the uniform layer containing first and second optical materials wherein the first optical material concentration is constant; and

forming a second graded layer on the first graded layer, the second graded layer comprising the first and second optical materials wherein the concentration of the first optical material decreases with the height of the second graded layer;

wherein the index of refraction of the uniform layer is greater than the index of refraction of the first and the second graded layers.

APPENDIX C

THE CLAIMS THAT WILL BE PENDING UPON ENTRY OF THE PRESENT AMENDMENT UNDER 37 C.F.R. § 1.111 IN RESPONSE TO THE OFFICE ACTION MAILED 10/01/02

U.S. PATENT APPLICATION SERIAL NO. 09/866,172 (ATTORNEY DOCKET NO. 005926/AKT/BG)

1. (Amended) A method of forming a planar waveguide structure, comprising:

forming a first graded layer on a substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the first graded layer; and

forming a second graded layer immediately over the first graded layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

2. The method of claim 1 further comprising forming a blocking layer between the substrate and the first graded layer wherein the blocking layer prevents contaminants from the substrate from diffusing into the first or the second graded layers.

3. The method of claim 2 wherein the blocking layer comprises epitaxial silicon.

4. The method of claim 1 further comprising forming a cladding layer on the second graded layer.

5. The method of claim 4 wherein the cladding layer comprises epitaxial silicon.

6. The method of claim 1 wherein the germanium concentration in the first graded layer increases linearly.

7. The method of claim 1 wherein the germanium concentration in the graded layer increases from about 0% germanium to about 2-5% germanium at a rate between about 0.1% per µm to about 10% per µm.

8. The method of claim 1 wherein the germanium concentration in the first graded layer increases from about 0% germanium to about 2% germanium at a rate of about 10 % per µm.

9. The method of claim 1 wherein the germanium concentration in the second graded layer decreases linearly.

10. The method of claim 1 wherein the germanium concentration in the second graded layer decreases from about 2-5% germanium to about 0% germanium at a rate between about 0.1% per µm to about 10% per µm.

11. The method of claim 1 wherein the germanium concentration in the second graded layer decreases from about 2% germanium to about 0% germanium at a rate of about 10% per µm.

12. The method of claim 1 wherein the layers are formed by a chemical vapor deposition process.

13. The method of claim 12 wherein the layers are formed epitaxially.

14. The method of claim 12 wherein the chemical vapor deposition process is a low pressure chemical vapor deposition process.

15. The method of claim 13 wherein the waveguide structure is formed using a selective deposition technique.

16. (Amended) The method of claim 13 wherein the chemical vapor deposition process comprises:

introducing into a deposition chamber a first source gas for forming silicon film on a substrate;

introducing into a deposition chamber a second source gas for forming SiGe film on a substrate; and

introducing H_2 into the deposition chamber while maintaining a determined pressure and temperature in the deposition chamber.

17. The method of claim 16 wherein the first source gas is silane, disilane, trisilane, dichlorosilane, or trichlorosilane.

18. The method of claim 16 wherein the second source gas is germane or digermane.

19. The method of claim 16 wherein the first source gas is silane and the second source gas is germane.

20. (Amended) The method of claim 16 wherein the chemical vapor deposition process for forming the first and second graded layers comprises:

controlling the flow rate of the second source gas according to a determined concentration profile of Ge on a substrate; and

forming a film on a substrate, the film comprising Ge at a first concentration at a first point in the film and a second concentration different from the first concentration at a second point in the film.

21. The method of claim 20 wherein the concentration profile is determined by:

determining a concentration of Ge formed on a substrate for a plurality of flow rates;

determining a growth rate of SiGe on a substrate for a second plurality of flow rates;

determining a concentration profile of Ge for a unit of time; and

controlling the flow rate to form film at a graded concentration of Ge throughout the thickness of the film.

22. The method of claim 1 further comprising:

forming a pattern on the first graded layer; and

etching the patterned first graded layer before forming the second graded layer on the first graded layer.

23. (Amended) A method of forming a planar waveguide structure, comprising:

etching a pattern into a substrate;

forming a first graded layer within said pattern, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the layer;

forming a uniform layer on the first graded layer, the uniform layer containing silicon and germanium wherein the germanium concentration is constant; and

forming a second graded layer on the uniform layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

24. The method of claim 23 wherein the germanium concentration in the uniform layer is in the range of about 2 - 5 %.

25. The method of claim 23 wherein the germanium concentration in the uniform layer is approximately 2%.

26. The method of claim 23 wherein the thickness of the uniform layer is in the range of about 2-5 μm.

27. The method of claim 23 wherein the thickness of the uniform layer is approximately 2 μm.

28. The method of claim 23 further comprising forming a blocking layer between the substrate and the first graded layer.

29. (Amended) The method of claim 28 wherein the blocking layer comprises epitaxial silicon.

30. The method of claim 23 further comprising forming a cladding layer on the second graded layer.

31. (Amended) The method of claim 30 wherein the cladding layer comprises epitaxial silicon.

32. The method of claim 23 wherein the germanium concentration in the first graded layer increases linearly.

33. The method of claim 23 wherein the germanium concentration in the first graded layer increases from about 0% germanium to about 2-5% germanium at a rate between about 0.1 % per μm to about 10% per μm.

34. The method of claim 23 wherein the germanium concentration in the first graded layer increases from about 0% germanium to about 2% germanium at a rate of 10 % per μm.

35. The method of claim 23 wherein the germanium concentration in the second graded layer decreases linearly.

36. The method of claim 23 wherein the germanium concentration in the second graded layer decreases from about 2-5% germanium to about 0% germanium at a rate between about 0.1 % per μm to about 10% per μm.

37. The method of claim 23 wherein the germanium concentration in the second graded layer decreases from about 2% germanium to about 0% germanium at a rate of about 10 % per μm.

38. The method of claim 23 wherein the layers are formed using a chemical vapor deposition process.

39. The method of claim 38 wherein the layers are formed epitaxially.

40. The method of claim 38 wherein the chemical vapor deposition process is a low pressure chemical vapor deposition process.

41. The method of claim 38 wherein the waveguide structure is formed using a selective deposition technique.

42. (Amended) The method of claim 29 wherein the chemical vapor deposition process comprises:

introducing into a deposition chamber a first source gas for forming silicon film on a substrate;

introducing into a deposition chamber a second source gas for forming SiGe film on a substrate; and

introducing H_2 into the deposition chamber while maintaining a predetermined pressure and temperature in the deposition chamber.

43. The method of claim 42 wherein the first source gas is silane, disilane, trisilane, dichlorosilane, or trichlorosilane.

44. The method of claim 42 wherein the second source gas is germane or digermane.

45. The method of claim 42 wherein the first source gas is silane and the second source gas is germane.

46. (Amended) The method of claim 42 wherein the chemical vapor deposition process for forming the first and second graded layers comprises:

controlling the flow rate of the second source gas according to a determined concentration profile of Ge on a substrate; and

forming a film on a substrate, the film comprising Ge at a first concentration at a first point in the film and a second concentration different from the first concentration at a second point in the film.

47. The method of claim 46 wherein determining the concentration profile comprises:

determining a concentration of Ge formed on a substrate for a plurality of flow rates;

determining a growth rate of SiGe on a substrate for a second plurality of flow rates;

determining a concentration profile of Ge for a unit of time; and

controlling the flow rate to form film at a graded concentration of Ge throughout the thickness of the film.

48. The method of claim 23 further comprising:

forming a pattern on the uniform layer; and

etching the patterned uniform layer and the first graded layer before forming the second graded layer on the uniform layer.

49. The method of claim 48 further comprising:

forming an oxide layer on the etched patterned uniform layer before forming the second graded layer on the uniform layer.

50. The method of claim 49 wherein the height of the oxide layer is approximately equal to the height of the first graded layer.

51. (Amended) A computer readable medium comprising executable program instructions that when executed cause a digital processing system to perform a method comprising:

forming a first graded layer on a substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the first graded layer; and

forming a second graded layer immediately over the first graded layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

52. The method of claim 51 wherein the executable program instructions include instructions for forming layers using chemical vapor deposition process.

53. (Amended) The method of claim 51 wherein the chemical vapor deposition process comprises executable program instructions for:

introducing into a deposition chamber a first source gas for forming silicon film on a substrate;

introducing into a deposition chamber a second source gas for forming SiGe film on a substrate; and

introducing H_2 into the deposition chamber while maintaining a determined pressure and temperature in the deposition chamber.

54. The method of claim 51 wherein the executable program instructions for forming the first and second graded layers comprises instructions for:

controlling the flow rate of the second source gas according to a determined concentration profile of Ge on a substrate;

forming a film on a substrate, the film comprising Ge at a first concentration at a first point in the film and a second concentration different from the first concentration at a second point in the film.

55. The method of claim 54 wherein the executable program instructions for determining the concentration profile comprises instructions for:

determining a concentration of Ge formed on a substrate for a plurality of flow rates;

determining a growth rate of SiGe on a substrate for a second plurality of flow rates;

determining a concentration profile of Ge for a unit of time; and

controlling the flow rate to form film at a graded concentration of Ge throughout the thickness of the film.

56. The method of claim 51 wherein the executable program instruction include instructions for forming the layers epitaxially.

57. (Amended) A method of forming a planar waveguide structure, comprising:

etching a pattern in a substrate;

forming a first graded layer on the pattern etched in the substrate, the first graded layer comprising silicon and germanium wherein the germanium concentration increases with the height of the layer;

forming a uniform layer on the first graded layer, the uniform layer containing silicon and germanium wherein the germanium concentration is constant; and

forming a second graded layer on the uniform layer, the second graded layer comprising silicon and germanium wherein the germanium concentration decreases with the height of the second graded layer.

58. The method of claim 57 further comprising planarizing the uniform layer prior to forming the second graded layer.

59. The method of claim 58 wherein the planarizing step is performed using a chemical mechanical polishing process.

60. (Amended) A method of forming a planar waveguide structure, comprising:

forming a first graded layer on a substrate, wherein the first graded layer comprises a first and a second optical material, wherein the concentration of the first optical material and the index of refraction of the first graded layer increases with the height of the first graded layer; and

forming a second graded layer immediately over the first graded layer, the second graded layer comprising the first and second optical materials wherein the concentration of the first optical material and the index of refraction of the second layer decreases with the height of the second graded layer.

61. (Amended) A method of forming a planar waveguide structure, comprising:

etching a pattern into a substrate;

forming a first graded layer within said pattern, wherein the first graded layer comprises a first and a second optical material, wherein the concentration of the first optical material and the index of refraction of the first graded layer increases with the height of the first graded layer;

forming a uniform layer on the first graded layer, the uniform layer containing first and second optical materials wherein the first optical material concentration is constant; and

forming a second graded layer on the first graded layer, the second graded layer comprising the first and second optical materials wherein the concentration of the first optical material decreases with the height of the second graded layer;

wherein the index of refraction of the uniform layer is greater than the index of refraction of the first and the second graded layers.